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Proceedings of the Regional Peer Review on the Assessment of the Gulf of St. Lawrence (4RST) Greenland Halibut stock

February 13-14, 2023
Mont-Joli, QC

Chairperson: Hugo Bourdages
Editor: Sonia Dubé

Maurice Lamontagne Institute
Fisheries and Oceans Canada
850, route de la mer, P.O. Box 1000 Mont-Joli, Quebec
Canada G5H 3Z4

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Canada

Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings may include research recommendations, uncertainties, and the rationale for decisions made during the meeting. Proceedings may also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

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SUMMARY

This document outlines the proceedings of the regional peer review meeting on the assessment of the Gulf of St. Lawrence (4RST) Greenland halibut stock. This meeting, which was held on February 13-14, 2023 at the Maurice Lamontagne Institute in Mont-Joli, brought together about fifty participants from science, industry and management. These proceedings detail the essential parts of the presentations and discussions held during the meeting, as well as the recommendations and conclusions made.

INTRODUCTION

The Quebec Region of Fisheries and Oceans Canada (DFO) is responsible for assessing several stocks of fish and invertebrate species harvested in the Estuary and Gulf of St. Lawrence. Most of these stocks are periodically assessed as part of a regional advisory process that is conducted at the Maurice Lamontagne Institute in Mont-Joli. This document outlines the proceedings of the meeting on the assessment of the Gulf of St. Lawrence (4RST) Greenland halibut held on February 13-14, 2023.

The objective of the meeting was to determine whether there were any changes in the resource's status and whether adjustments were required to the management plans based on the chosen conservation approach, with the ultimate goal being to provide a science advisory report on the management of the Gulf of St. Lawrence Greenland halibut stock (4RST) for the 2023-2024 and 2024-2025 fishing seasons.

These proceedings report on the main points discussed in the presentations and deliberations stemming from the activities of the regional stock assessment committee. The regional peer review meeting is a process open to all participants who are able to provide a critical outlook on the status of the assessed resources. Accordingly, participants from outside DFO are invited to take part in the committee's activities within the defined framework for this meeting (Appendices 1 and 2). The proceedings also list the recommendations made by the meeting participants.

ASSESSMENT

Chair Hugo Bourdages welcomed the participants and went over the objectives and process for the science review, as well as the role of the participants. The terms of reference and agenda (Appendix 3) were presented. The participants were then asked to introduce themselves.

The stock assessment biologist, Jean-Martin Chamberland, opened his presentation by highlighting the contributions of many collaborators and then presenting some data on the biology, habitat and distribution of Greenland halibut. The Gulf of St. Lawrence population is considered to be unique and distinct from the Northwest Atlantic population. Greenland halibut are found mainly in channels at depths ranging from 200 m to 375 m. Juveniles are predominant in the Lower Estuary and north of Anticosti Island and are generally found at shallower depths than adults. Spawning occurs in winter, in the deeper portions of the Laurentian Channel southwest of Newfoundland. Greenland halibut are slow growing and late to mature. They exhibit size dimorphism, as their growth slows at sexual maturity. Males reach sexual maturity at smaller sizes than females, at about 36 cm, compared to 46 cm for females.

Ecosystem considerations were incorporated into the presentation. In particular, it was noted that the Gulf of St. Lawrence is undergoing significant changes, with water temperatures increasing and oxygen levels declining in the deeper parts of the Gulf. In addition, changes in community structure (high redfish abundance and low prey abundance) are being observed, which could negatively affect Greenland halibut productivity. Current environmental conditions and climate projections suggest that the situation is likely to remain unfavourable to the species.

- Questions were raised about the competition between redfish and Greenland halibut for habitat, although their competition for food resources appears to be more evident.
- Participants wondered about the ability of Greenland halibut to adapt to environmental changes. This issue is a significant source of uncertainty, as predicting with any accuracy how the species will respond appears difficult.

FISHERY

Jean-Martin Chamberland provided an overview of the Greenland halibut fishery in 4RST. The fishery is dominated by fixed gear, with gillnets accounting for 99% of the catches. During the 2022-2023 fishing season, preliminary landings in the Gulf of St. Lawrence totalled 929.8 t, or 46% of the fixed-gear fishing allocation. This is the lowest value observed since 1975. Since 2013, fishing effort has followed a downward trend throughout the Gulf, with current levels the lowest in the 1999-2022 period. In 2022, over 80% of the fishing effort was concentrated in the western Gulf sector, where the fishery performance index has been increasing since 2018 and, in 2022, it was close to the time-series average. In the northern Anticosti sector, this index appears to have been stable since 2020 and was slightly below the series average in 2022, while, in the Esquiman sector, it has been well below average since 2014.

The composition of landings was stable from 2019 to 2022. The average length of individuals was below the mean value, and the proportion of fish below the minimum legal size (roughly 30%), was greater than the mean value.

- Some details were provided on the small-fish protocol in the groundfish fishery.
- Bycatch information appears to be considered in adjusting the management strategies. However, it was noted that catches by shrimpers are not included in Greenland halibut landings.

DFO SURVEYS AND SENTINEL SURVEY

According to the three scientific surveys, the abundance and biomass indices have followed a downward trend since the mid-2000s. The cohorts that were expected to contribute to the fishery in 2023 and 2024 consist of the 2016 cohort, low in abundance, and the 2017 and 2018 cohorts, high in abundance. These cohorts were growing at a normal rate, but their poor condition in 2022 could negatively affect their growth. The low abundance of age-1 individuals observed in the scientific surveys from 2020 to 2022 could negatively impact the biomass available to the fishery in the medium term.

- It was noted that the different surveys provide an interesting historical perspective.
- According to the data from the DFO winter surveys conducted on board the *Gadus* and the *Mersey Venture*, Greenland halibut move to deeper waters during winter. In 2022, they were found in deeper waters (*Mersey Venture*) than during the 1978-1994 period (*Gadus*), but this difference could be due to a difference in the areas and depths covered by these two surveys.
- The strong 1997-1999 cohorts stand out in the size-frequency graph obtained from the sentinel fisheries survey.
- A stock-recruitment relationship is present, but the same fit was obtained with the different models. At this time, temperature does not appear to be affecting recruitment, although it may eventually have a negative impact.
- In 2022, a lower condition index was observed for all size classes, with a density-dependent phenomenon observed. Deep-water warming and oxygen depletion could also account for this, although these conditions did not vary as much from previous years. Low prey abundance is another possible explanation; this hypothesis is supported by the low value for the stomach fullness index.
- Participants wondered about the estimation of L_{50}, since different weightings seemed to provide the same results. This estimate is subject to classification error due to the fact that

stage of maturity is determined by the visual examination of the gonads (macroscopic examination) outside the spawning period.

SELECTIVITY OF NGSL SURVEY

The following section discusses the shape of the selectivity function for Greenland halibut in the northern Gulf of St. Lawrence (nGSL) survey. The shape of this function for large individuals of the species in the nGSL bottom trawl survey is uncertain. Logistic or sigmoidal selectivity would imply that all large individuals are selected in the survey, while dome-shaped selectivity would mean that large individuals can, for example, swim out of the trawl. In the context of modelling the population dynamics of this stock, these two potential selectivity functions result in a very different interpretation of the length-frequency distributions obtained in the nGSL survey, as well as stock productivity and probably the demographic factors affecting it. Various analyses were conducted to examine these two types of selectivity functions in greater depth, with the results suggesting that nGSL survey selectivity is sigmoidal.

- The participants concluded that the low abundance of large individuals in the nGSL survey reflects low relative abundance rather than fishing gear avoidance. This indicates a high total mortality rate for individuals over 40 cm.
- In general, an increase in the average size of individuals is observed as the depth increases. The nGSL is not as deep as the surrounding areas. Therefore, the pattern observed appears to be consistent with the available deep-water habitat.

UNACCOUNTED-FOR MORTALITY IN THE GILLNET FISHERY

Generally, the Greenland halibut gillnet fishery has involved lengthy soak times, with the prescribed maximum time of 72 hours exceeded on most trips. These extended soak times have been previously associated with catch deterioration and the loss of individuals that escape from the nets or are subject to predation before the nets are hauled in. These losses are a source of unaccounted-for fishing mortality that increases with soak time, and the magnitude of this drop-off mortality is unknown. Analyses have been conducted to better understand the relationship between soak time and landed biomass, discard amounts and fish condition based on at-sea observer data. Experiments were also begun in 2022 to assess fish decomposition as a function of soak time.

The results showed that the quantity of fish landed tends to peak at soak times of about 72 hours. In addition, the proportion of discards in Greenland halibut catches tends to increase with soak time. Estimated decomposition rates in the summer of 2022 were high, and could explain the initial decrease in landings, followed by an increase in landings as a function of soak time during the first 48 hours. Ongoing soak time and decomposition experiments in 2023, as well as the collection of decomposition data by at-sea observers, will be useful in estimating unaccounted-for mortality in the directed Greenland halibut gillnet fishery. In conclusion, the use of short soak times is encouraged in this fishery.

- Regarding the relationship between landed biomass and soak time, it was noted that the available data do not allow the effects of year, month or fishing areas to be studied. A random factor was used as a nuisance parameter to account for different densities of Greenland halibut in space and time.
- Fishers also mentioned that they have observed catches increase with soak time but noted that other factors, such as the phase of the moon, can also influence catches.
- Regarding the soak time and decomposition experiments, questions were raised about the effect of fish size and condition on decomposition, and about the repercussions of exposing

fish to the air. Participants were reminded that the idea is to measure decomposition after death. It is difficult to use manipulations to estimate actual mortality in nets, given the stress experienced by individuals. Eventually, we would like to better examine the probability of Greenland halibut dying in nets so that we can better estimate the decomposition rate and losses.

- From the perspective of a sustainable fishery, the participants wondered about the possibility of determining an optimal soak time in order to minimize losses. Industry representatives noted that there is a quite a difference between an ideal strategy and the actual situation in the field.
- The possibility of using underwater cameras was raised. In addition to the technical difficulties involved, it was noted that there is little light at these depths and questions were raised on the effect that the light from the camera would have on the species. This approach seems unrealistic.

EXPLOITATION RATES AND PRECAUTIONARY APPROACH

Relative exploitation rates were presented by fishing area and for the entire Gulf (4RST). These exploitation rates were calculated from the landed quantities and do not take account of unaccounted-for fishing mortality. The exploitation rates for the entire Gulf were 3.35% in 2021 and 3.10% in 2022, well below the average of 6.3% for the 1996-2022 time series. The exploitation rate was the lowest ever observed.

Under the precautionary approach, the estimated value for the stock status indicator (33,135 t) in 2022 was between the limit reference point and the upper stock reference, at the top of the cautious zone. The maximum harvest is expected to be 2,002 t for the 2023-2024 and 2024-2025 management years, which corresponds to a projected exploitation rate of 6%.

- The probability of the stock being in the different zones was calculated but does not appear to be useful for Management at this time.
- Given the change in productivity, participants wondered about the validity of the current limit reference point. It appears to be the best we have at this time. At the same time, work is underway to develop a new model that will improve stock assessment.

INTERIM YEAR

The Greenland halibut stock assessment is conducted every two years. In the interim years, a stock status update on the biomass of Greenland halibut over 40 cm in length will be produced. In the event of exceptional circumstances in an interim year, such as a change of more than 30% (relative to the previous year) in the biomass indicator, the projected harvest under the harvest control rule will be recalculated.

- Participants wondered about the 30% value. Where did it come from? This is the threshold that was considered significant in the past.
- Participants wondered whether this value (a change of more than 30%) applies in both directions (decrease and increase).
- Fisheries Management representatives confirmed that the change applies in both directions and agreed with the proposed approach.

SOURCES OF UNCERTAINTY

Various sources of uncertainty were raised:

- Size at maturity in the nGSL survey
- Environmental effects on growth, survival, behaviour and survey catchability
- Age determination
- Unaccounted-for mortality in the directed gillnet fishery
- Lack of coverage by at-sea observers in the Newfoundland and Labrador Region in 2021 and 2022

Other items that may affect the stock were mentioned:

- Greenland halibut catches in the mobile gear fishery
- The possible reopening of the redfish fishery
- Competition between redfish and Greenland halibut for habitat and food

CONCLUSION

HIGHLIGHTS AND RECOMMENDATIONS

The highlights were presented, and the participants commented on them. Comments having to do with stylistic rewording are not reported.

- In the highlight on fishing effort, it seemed relevant to mention that fishing effort was concentrated in the western Gulf in 2022.
- The document will state that the price of fuel has strongly contributed to the decrease in effort.
- The item regarding the abundance of individuals aged 1 year was reviewed, and it was agreed that, according to the scientific surveys, the low abundance of individuals aged 1 year observed from 2020 to 2022 would have a negative impact on the biomass available to the fishery in the medium term.
- In the bullet point on ecosystem changes, the participants preferred that the conditional tense be used to discuss impacts on Greenland halibut, without going into detail, in order to be brief and concise. It was suggested that this highlight be moved to the end of the summary.

The participants' **conclusion** is as follows:

Under the precautionary approach, the stock status indicator, estimated at 33,135 t, placed the stock at the top of the cautious zone in 2022. Under the harvest control rule, all sources of removals should not exceed 2,002 t in 2023-2024 and 2024-2025

RESEARCH PROJECTS

The following research was identified as a priority for the future:

- Genomic structure of the Greenland halibut population (3P, 4RST, 4Vns)
- Spatio-temporal modelling of length at maturity incorporating a classification error to identify the population structure and changes in the life history of Greenland halibut in the Northwest Atlantic

- Estimation of unaccounted-for mortality in the Greenland halibut commercial fishery (NAFO Divisions 4RST) and solutions for a more sustainable, efficient fishery
- Size at maturity of 4RST Greenland halibut by histological and macroscopic analyses of the gonads
- Winter groundfish survey in the Gulf and the Laurentian Channel (distribution, size at maturity)
- Development of a stock assessment model

Participants made the following suggestions:

- A tagging project like the one for Atlantic halibut. Industry representatives expressed an interest in participating.
- Improvement of at-sea observer data
- Age determination program

APPENDIX 1 - TERMS OF REFERENCE

Assessment of the Gulf of St. Lawrence (4RST) Greenland Halibut Stock

Regional Peer Review - Quebec Region

February 13-14, 2023
Mont-Joli, QC

Chairperson: Hugo Bourdages

Context

The Gulf of St. Lawrence (4RST) Greenland halibut (turbot) fishery is conducted by inshore fixed-gear fleets from Quebec and the west coast of Newfoundland. This fishery is subject to several management measures including a total allowable catch (TAC). The current assessment is requested by the Fisheries Management Branch to provide detailed advice on the status of 4RST Greenland halibut in order to inform management decisions for this stock for the upcoming management cycle.

Objectives

Provide scientific advice on Greenland halibut stock status in NAFO Divisions 4RST. This advice shall include:

- An oceanographic and environmental overview for the stock area;
- Analysis of the commercial fishing data including landings, fishing effort, catch per unit effort, biological data, Greenland halibut by-catches in other fisheries and by-catches in Greenland halibut directed fishery;
- Analysis of data from the DFO annual research trawl survey and mobile sentinel fisheries program, including biomass, exploitation rates, biological characteristics, length composition, length at maturity and spatial and environmental distribution;
- An assessment of the selectivity of the northern Gulf research survey and its implication on the interpretation of the demographic structure observed in it;
- A presentation of the stock-recruitment relationship;
- Preliminary analyses of the impact of extended immersion times on the quality and mortality of Greenland halibut;
- A presentation of the stock status and outlook for 2023-2024 and 2024-2025 in relation to the Precautionary Approach reference points and projected removals under the harvest control rule;
- The determination of the process to provide advice during the interim years including a description of conditions that may warrant adjustments to the current management approach;
- Identification of key sources of uncertainty in the assessment;
- Identification and prioritization of research projects to be considered for the future.

Expected Publications

- Science Advisory Report

- Research Document
- Proceedings

Expected Participation

- Fisheries and Oceans Canada (DFO) (Science and Fisheries Management sectors)
- Fishing industry
- Provincial representatives
- Indigenous Groups
- External experts

APPENDIX 2 - LIST OF PARTICIPANTS

Name	Affiliation	Febr. 13	Febr. 14
Beaudry-Sylvestre, Manuel	DFO – Science	x	x
Benoit, Hugues	DFO – Science	x	x
Bernier, Denis	DFO – Science	x	-
Bois, Samantha	ACPG	x	x
Bouchard, Donald	Essipit First Nation	x	-
Boucher, Jean-René	RPPNG-OPFGQ	x	x
Boudreau, Mathieu	DFO – Science	x	x
Boudreau, Sophie	DFO – Science	x	x
Bourdages, Hugo	DFO – Science	x	x
Bourbonnière, Jean-Patrick	DFO – Science	x	x
Brûlé, Caroline	DFO – Science	x	x
Byrne, Vanessa	Province of Newfoundland and Labrador	x	x
Chabot, Denis	DFO – Science	x	-
Chamberland, Jean-Martin	DFO – Science	x	x
Chlebak, Ryan	DFO – Science Ottawa	x	x
Condo, Jaime	Micmacs of Gesgapegiag Band	x	x
Cormier, Julien	DFO – Fisheries Management Gulf	x	x
Cyr, Charley	DFO – Science	x	x
Denis, Marcel	ACPG	x	-
Dennis, Olivia	Province of Newfoundland and Labrador	x	x
Desgagnés, Mathieu	DFO – Science	x	x
Devine, Brynn	Oceans North	x	x
Dubé, Frank	Fisher	x	-
Dubé, Sonia	DFO – Science	x	x
Dugas, Franky	Fisher	x	-
Duplisea, Daniel	DFO – Science	x	x
Dwyer, Shelley	DFO – Fisheries Management NL	x	x
Émond, Kim	DFO – Science	x	x
Gianasi, Bruno	DFO – Science	x	-
Laurie, Isabel	DFO – Science	x	-
Langelier, Serge	AMIK	x	x
Lussier, Jean-François	DFO – Science	x	-
Marquis, Marie-Claude	DFO – Science	x	x
Martin, Lucas	UQAR	x	-
Miville, Emmanuel	Fisher	x	-
Monger, Julie	APBCN	x	-
Nadeau, Paul	APBCN	x	x
Nicolas, Pierre	OPFGQ	x	-
Ouellette-Plante, Jordan	DFO – Science	x	x
Parent, Lyndsey	Première Nation de Listugug	x	x
Pond, Nancy	DFO – Fisheries Management NL	x	x
Pinette, Majoric	Conseil des Innus Pessamit	x	x
Rondeau, Marie-Maude	DFO – Science	x	x
Roux, Marie-Julie	DFO – Science	x	-
Sandt-Duguay, Emmanuel	AGHAMW	x	x
Senay, Caroline	DFO – Science	x	x
Sigouin, Evelyne	PNWW - AGHAMW	x	-
Smith, Andrew	DFO – Science	x	x
Solberg, Abe	FFAW	x	x
Tremblay, Yan	UAPAN	x	-
Trottier, Steve	DFO – Fisheries Management Québec	x	x

APPENDIX 3 – AGENDA

Assessment of Estuary and Gulf of St. Lawrence (NAFO 4RST) Greenland halibut stock in 2022

Regional Peer Review – Quebec region

February 13-14, 2023

February 13, 2023

Time (EST)	Subject
9:00	Introduction and round table
9:30	Species biology and ecosystemic context
10:00	*Break*
10:15	Commercial fishery
11:15	Scientific surveys
12:00	*Lunch break*
13:00	Scientific surveys
13:30	Stock – recruitment relationship
13:45	Shape of the nGSL survey sélectivité function
14:15	Unaccounted mortality in the gillnet fishery
14:45	*Break*
15:00	Exploitation rate and Precautionary Approach
15:45	Interim years
15:50	Sources of uncertainty

February 14, 2023

Time (EST)	Subject
9:00	Intro and wrap up of previous day
09:15	Review of Science advisory summary
10:00	*Break*
10:15	Review of Science advisory summary
11:00	Identification and prioritization of research projects to be considered for the future